

WATERPOWER

HYDRO BASICS

JULY

15-16, 2024

**COLORADO CONVENTION CENTER
DENVER, COLORADO**

CO-LOCATED WITH



Day-to-Day Operations

Session Leader

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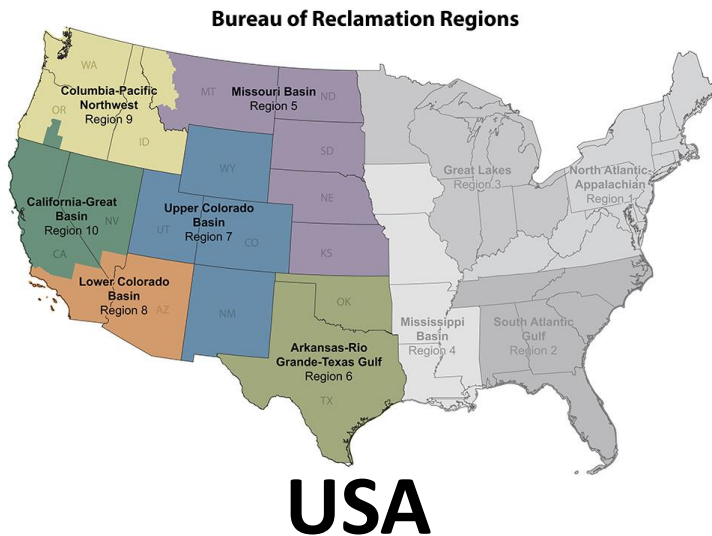
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Instructor

Nathan E. Myers (1.0), P.E.

Electrical Engineering Manager, Hydropower Diagnostics and SCADA Group
Bureau of Reclamation – Technical Service Center

Who is the Bureau of Reclamation?



- **17 Western States**
- **176 Rotating Units**
- **Hold title to 78 power facilities**
- **Operate 53 power facilities**
- **14,760 MW of total Hydro Capacity**
- **490 dams and 294 reservoirs with a storage capacity of 140 million acre-feet**

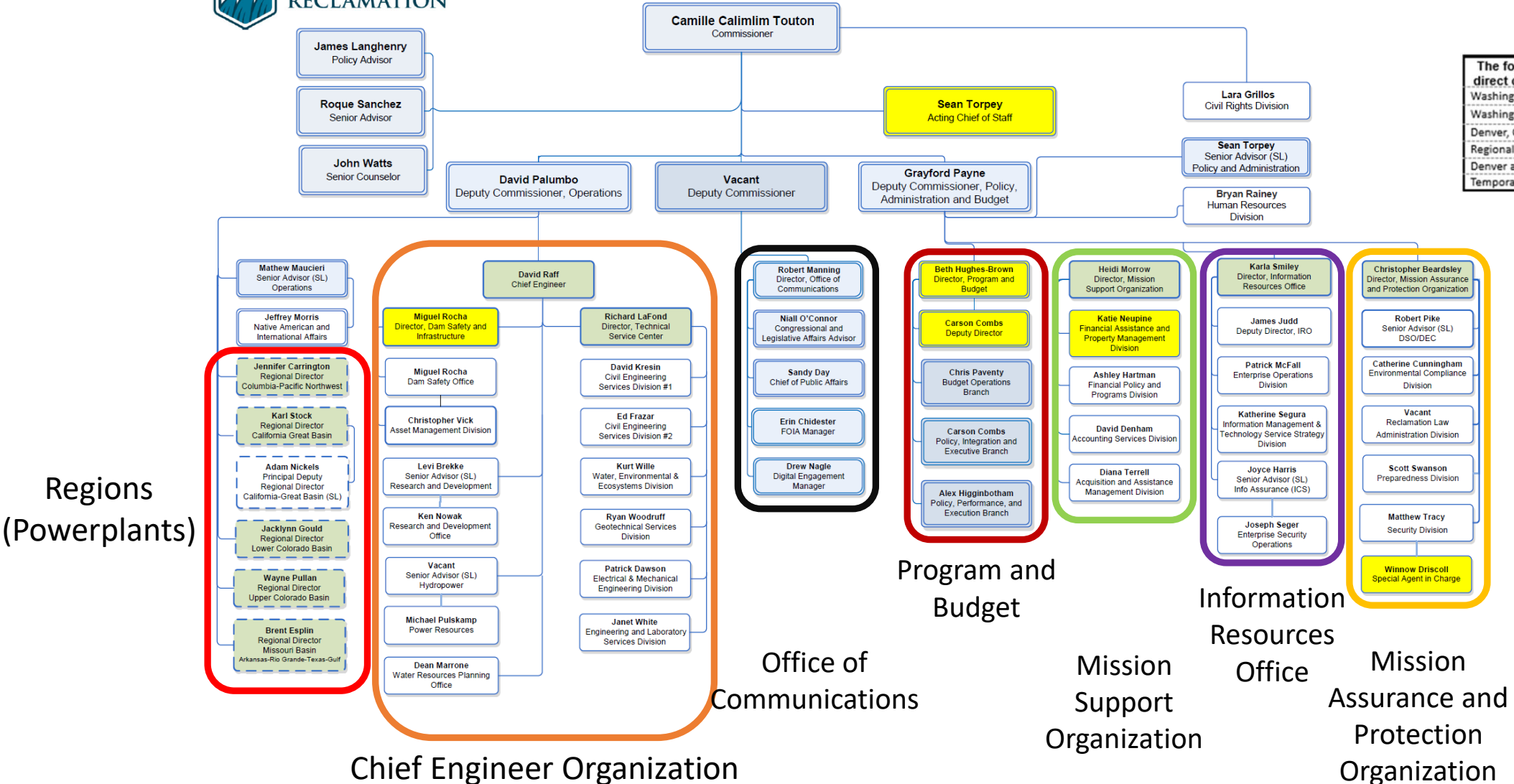




BUREAU OF
RECLAMATION

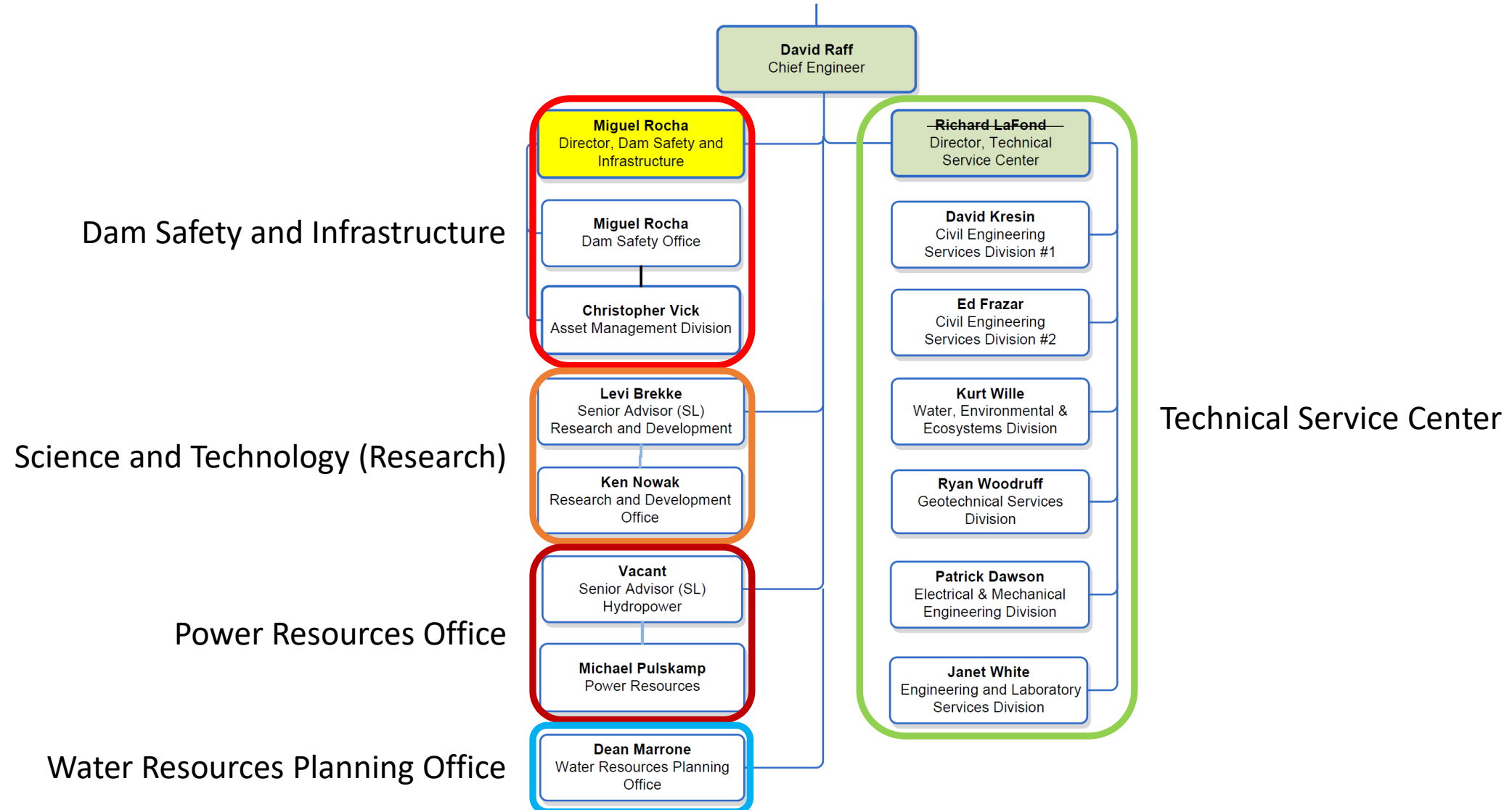
Bureau of Reclamation Organizational chart

May 2024



The following denotes office location and direct communication with Commissioner:

Washington, DC	Blue box
Washington, DC (located in Denver)	Blue box with diagonal lines
Denver, CO	Light blue box
Regional Offices	Light blue box with diagonal lines
Denver and Regional Directors	Green box
Temporarily Acting	Yellow box



Bureau of Reclamation – Chief Engineer Organizational chart

Background and Disclaimer

- Electrical Engineer with 22 years of service at Reclamation
- Manager of the Hydropower Diagnostics and SCADA Group under the TSC
- Primary job
 - Ensure power facilities operate as expected by providing:
 - Onsite field support
 - Innovating and documenting Operations and Maintenance (O&M) best practices
 - Assist in writing job plans
 - Perform Condition Assessments
 - Providing training to the crafts
 - Remote support
 - Both knowledge and equipment

Disclaimer: I am not a powerplant supervisor, but I have assisted others in performing these tasks and spoke with several powerplant supervisors to put this presentation together.

Day-to-Day Operations

- Safety, Security, and Environmental Concerns
- Budget and Maintenance
- Plant alarms
- Operations of the units and spillways
- Labor Union Agreements
- Community (Plant tours, meetings, etc.)
- Major Projects and Contracting
- Tying it all together – *“A Typical Day at the Plant”*

Facility Manager

- Hires, supervises, mentors, and develops employees
- Coordinates activities with external support services (Technical Service Center, contractors, for environmental, compliance, safety, and health)
- Communicates information from upper management to the plant team and back up the chain
- Coordinates outages within region and with transmission owner/operators
 - Takes care of unplanned outages quickly and efficiently
- Ensures compliance with regulatory agencies such as NERC/WECC
- Responsible for the plant budget
- Keeps the lights on

Facility Manager

- Hires, supervises, mentors, and develops employees
- Coordinates activities with external suppliers (Technical Service Center, contractors, environmental agencies) (safety and health)
- Communicates information forward and back up the chain to the plant team and back up the chain to the plant team and back up the chain to the plant team
- Coordinates outages and with transmission owner/operators
 - Takes care of outages quickly and efficiently
- Ensures compliance with regulatory agencies such as NERC/WECC
- Responsible for the plant budget
- Keeps the lights on

Ensures all employees have the proper training to meet the needs of the mission.

Safety of the Public

- Dam Safety / Emergency Action Plans (EAPs)
- Security
- Project Safety – reservoir, rivers, canals, dams, switchyards, and powerplants



Security of the Project

- The facilities are protected through numerous different strategies
 - Physical
 - Gates
 - Fences
 - Barricades
 - Police forces
 - Virtual
 - Cameras
 - Security systems
 - Card access
 - Information Technology
 - Cyber Attacks



Security of the Project



Safety:

For the Public, Reclamation Personnel, Contractors

- Reclamation Facilities Instructions, Standards and Techniques (FIST)
 - FIST 1-1: Hazardous Energy Control Program (HECP)
 - Annual training and certification
- Bringing in experts to provide a combination of On-the-Job and classroom training for specialized topics
- Mentoring for new employees
- JHAs, PPE, LOTO, etc.
- Stop work authority



Safety:

On the Job

- Safety briefings including Job Hazard Analysis
 - Beginning of each shift
 - If anything changes
 - If someone sees something unsafe
- Clearances and personal Lockout/Tagout
 - Generalized annual training
 - Facility specific annual training and testing
 - Employee Authorization List (EAL)
- Stop work authority
 - NO EMPLOYEE WILL BE REQUIRED TO WORK ON A JOB OR PIECE OF EQUIPMENT THAT THEY CONSIDER UNSAFE.



Safety: Job Hazard Analysis

- Every Job starts with the writing, reviewing, and modification of the Job Hazard Analysis (JHA)
 - All employees performing work on the specific task are required to attend.
 - Review the hazards associated with each job as well as mitigating factors for those hazards.
 - Special precautions or conditions
 - Hazardous Energy control <= not just electrical
 - Personal protective equipment
 - Physical address and phone number
 - Emergency contact information
 - Medical conditions or physical limitations



Bureau of Reclamation
 Any Area Office
 Any Field Division
 303-445-2643
 Denver Federal Center, Bldg 56
 Lakewood, CO 80225

RECLAMATION
Managing Water in the West

JOB HAZARD ANALYSIS
 Complete prior to beginning work, and with work crew at job-briefing before beginning work
 Have all affected personnel sign-off in Block 15 of this form.

JHA information WP#:	
Date Prepared:	06/22/2022
Submitted By:	R. Hogg
Reviewed By:	R. Egan
Approved By:	N. Myers
Revised By:	
Date:	

(1) JOB INFORMATION		
Date: 06/22/2022	Work Order Number: A-126	PM Number: 321,321,321
Job Description: CT, and PT, Burden test		

(2) EMERGENCY PROCEDURES	
Call Central Dispatch 911 or 9-911	Location of Work if known: Myers Powerplant
Fall Protection Rescue Procedures to be used:	<input checked="" type="checkbox"/> Fire Department <input type="checkbox"/> In-House Crew (Crew must be properly trained in rescue) <input checked="" type="checkbox"/> Other: Local responder

(3) JOB / TASKS (Note: Any rigging with a payload weight of 10T - 50T = Medium Lift, or > 50T = Heavy Lift, or a Critical Lift requires the submittal of an Engineer approved lift plan as required per contract requirements.)	
CHECK TYPE OF WORK BEING PERFORMED:	
<input checked="" type="checkbox"/> Working at Height > 6 feet <input type="checkbox"/> Heavy Lift (>50T), <input type="checkbox"/> Incidental Lift (<10T)	<input checked="" type="checkbox"/> Electrical <input type="checkbox"/> Welding <input type="checkbox"/> Construction <input type="checkbox"/> Heavy Equipment <input type="checkbox"/> Civil/Concrete/Masonry <input type="checkbox"/> Decommissioning <input type="checkbox"/> Scaffolding <input type="checkbox"/> Drilling <input checked="" type="checkbox"/> Other: TESTING

(4) JOBSITE EXPOSURES, NOTE: ELECTROMAGNETIC INTERFERENCE (EMI), RADIO FREQUENCY (RF)	
Hazard Identification: Items checked below relate to existing conditions or may be a result of site operations	
Physical Hazards	Health Hazards
<input type="checkbox"/> Confined Space <input type="checkbox"/> Permit Required <input checked="" type="checkbox"/> Electrical <input type="checkbox"/> Elevation / Site Terrain <input checked="" type="checkbox"/> Falls from Elevations <input type="checkbox"/> Fire Hazards <input type="checkbox"/> Heavy Equipment	<input checked="" type="checkbox"/> Struck by/Contact With <input type="checkbox"/> Overhead Work <input checked="" type="checkbox"/> Slips, Trip, or Falls <input type="checkbox"/> Underground Utilities <input type="checkbox"/> Vehicle Traffic <input type="checkbox"/> Other:
<input type="checkbox"/> Chemical Exposure <input type="checkbox"/> Cold Stress <input type="checkbox"/> EMI/RF/Radiological/Laser <input type="checkbox"/> Heat Stress <input checked="" type="checkbox"/> High Noise (>85 dBA) <input checked="" type="checkbox"/> Lifting Hazards	<input type="checkbox"/> Silica Exposure (Concrete/Stone Cutting) <input type="checkbox"/> Biological Hazards: Animals, Avian, Insects, Microbiological, etc. <input type="checkbox"/> Asbestos, Lead <input type="checkbox"/> Copper Magnesium <input type="checkbox"/> Other:

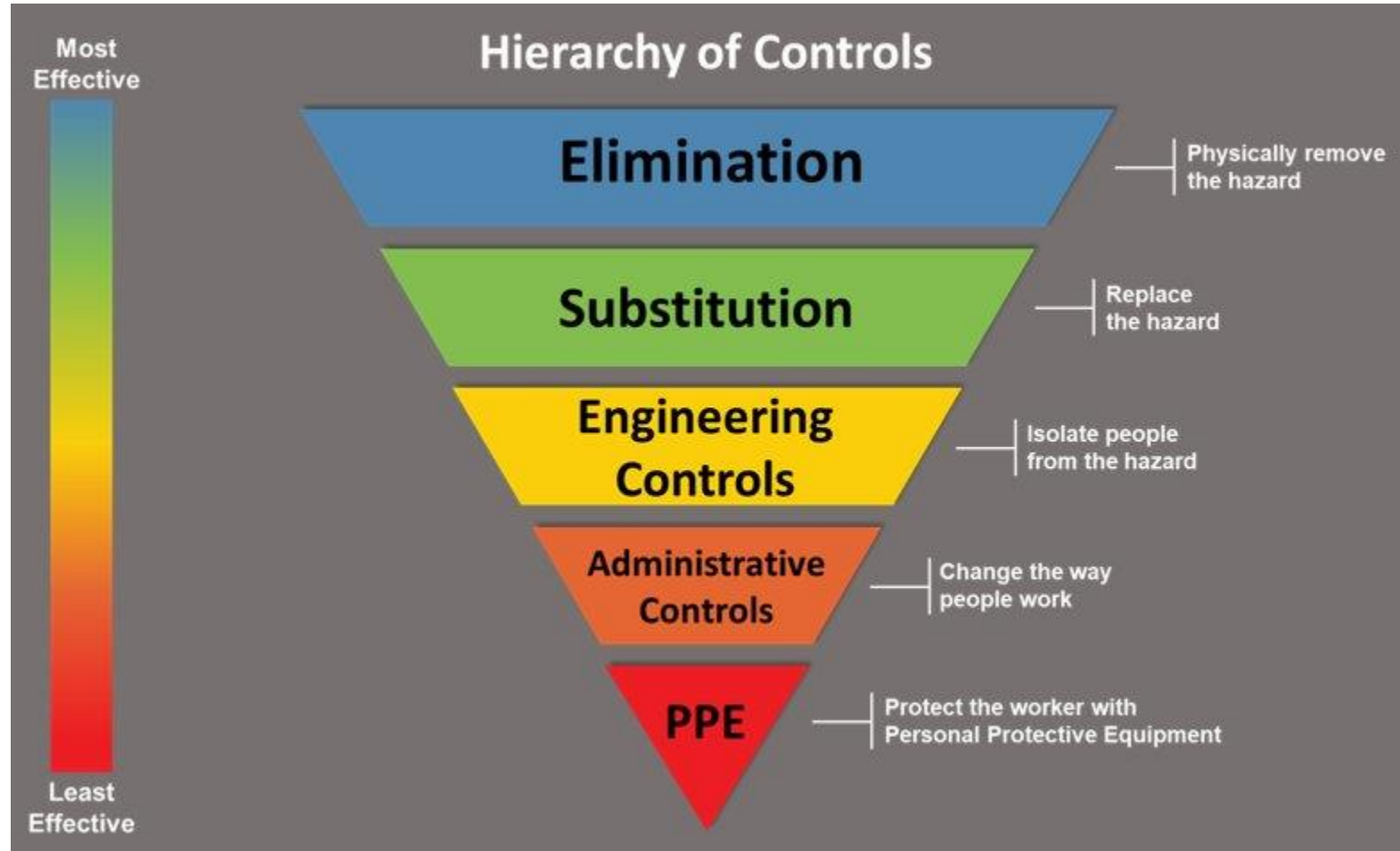
(5) HAZARD CONTROL MEASURES		
PPE and Monitoring Equipment	Inspections	Safety Systems / Training
<input type="checkbox"/> Fall Protection <input checked="" type="checkbox"/> Gloves <input checked="" type="checkbox"/> Hard Hat <input type="checkbox"/> Hearing <input type="checkbox"/> Respirator <input type="checkbox"/> Yes <input type="checkbox"/> No Type: <input type="checkbox"/> RF / Radiological Monitors <input type="checkbox"/> Hazmat Suits: Level: D, C, B, A <input checked="" type="checkbox"/> Safety Glasses, Goggles, Face Shield <input type="checkbox"/> Safety Vest: Follow RSHS standards <input type="checkbox"/> Air Monitoring: <input type="checkbox"/> Oxygen Deficiency (< than 19.5%) <input type="checkbox"/> Oxygen Enrichment (> than 23.5%) <input type="checkbox"/> Flammable Gases/Vapors (> than 10% of LEL) <input type="checkbox"/> Airborne Combustible Dust (> than LFL) <input type="checkbox"/> Toxic Gases or Vapors (> than PEL) <input type="checkbox"/> Laser Safety:	(Complete All Prior to Use) <input checked="" type="checkbox"/> Tools/Equipment <input type="checkbox"/> Rigging <input type="checkbox"/> Housekeeping <input type="checkbox"/> Tag Lines <input checked="" type="checkbox"/> Ground Fault Protection <input type="checkbox"/> Gin Poles <input type="checkbox"/> Hoists <input type="checkbox"/> Other:	<input type="checkbox"/> Barricades, Pedestrian Shelters, Banner of Notices, PPE, and Warning Signs <input type="checkbox"/> Excavation & Trenching Plan/Log <input checked="" type="checkbox"/> Lock-Out / Tag-Out <input checked="" type="checkbox"/> Job Briefing Meeting <input type="checkbox"/> Pre-Approved Plans (Critical Lifts, Roped-Access, Suspended Personnel Lift) <input type="checkbox"/> Color Coded Inspection Schemes for Rigging, Equip., Electrical Cords & Tools; Annotate Colors, Items, & Frequency. <input type="checkbox"/> Uniform Traffic Control <input type="checkbox"/> Permit Systems: Confined Spaces: Is a Permit Required? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Obtained <input type="checkbox"/> No Electrical Work: Is a Permit, Outage, or Clearance Required? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Obtained <input checked="" type="checkbox"/> No Fire, Smoke, Heat Alarms Deactivation: Are Permits Required? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Obtained <input type="checkbox"/> No Welding/Hot/Burning: Is a Permit Required? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Obtained <input type="checkbox"/> No Pressure/Chemical Pipe Opening: Is a Permit Required? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Obtained <input type="checkbox"/> No Egress Evacuation Routes Altered: Is a Permit Required? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Obtained <input type="checkbox"/> No

Hazardous Energy Sources

- Electrical
- Mechanical
- Chemical
- Pneumatic
- Hydraulic
- Stored



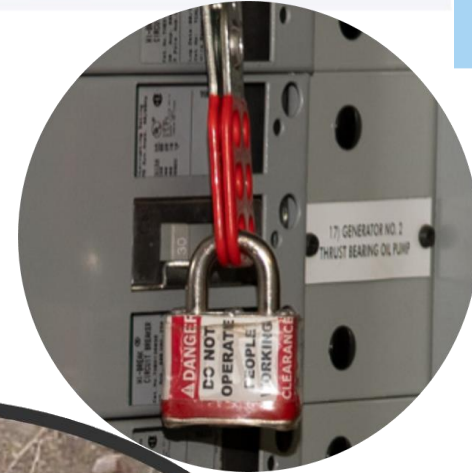
Safety: Working with Hazards



Safety: Clearances

- Every employee will lock and walk the entire clearance before beginning any work
- If anything does not look correct, they will ask for clarification and double check the prints and physical system
- Once walked and verified correct, the employee can begin work
- Once work is completed, and employees clear the area, employees must ensure they remove their lock so the equipment can be returned to service.

Never lock onto the last hole on a lockbox!!



Safety:

Stop Work Authority

- If any employee feels the work that is being performed is unsafe, they have the right and responsibility to stop work until the issue can be discussed and resolved.
 - While we can't remove all risks, we can ensure the work is being performed safely.

We will do everything within our power to ensure all employees make it home safely at the end of the day!!

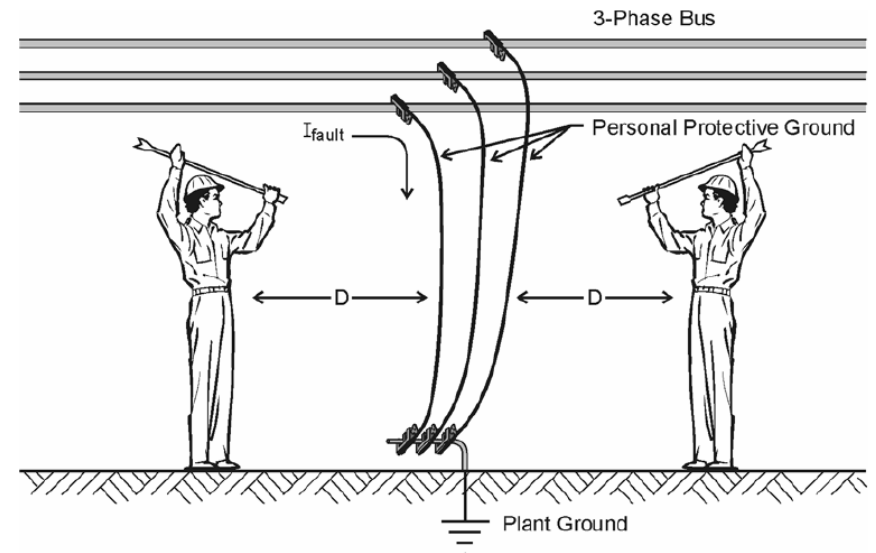
Safety:

Specialized Training

- Electrical safety
 - For all employees
- Fall protection
- Confined space entry
- Personal protective grounding

Facilities Instructions, Standards, and Techniques
Volume 5-1

Personal Protective Grounding for Electric Power Facilities and Power Lines



Safety:

Specialized Testing

- Specialized work requires specialized procedures.
 - Field staff are extremely familiar with their equipment and safety practices at their facility.
 - Centralize engineering staff is often familiar with specialized testing and the risks associated with complex testing procedures.
 - Both groups must work together to complete the work as needed in a safe manner.



Maintenance

- Operating a hydropower facility requires a large amount of maintenance which correlates into significant costs in both labor and non-labor.
 - Optimizing maintenance tasks and intervals is critical.
 - Utilizing technology is also key to decrease maintenance costs and improve reliability.
 - Maintenance Improvement Initiative ensures work is completed at the optimal interval and that the right tasks are being performed.



Maintenance

- Planning and scheduling of outages and special projects.
- Planning budgets for future years.
- Inventory for maintenance activities.
 - Including consumables and replacement parts
- Ensuring proper staffing and experience.
- Coordination with the system Control Center.



Technical Services Coordination



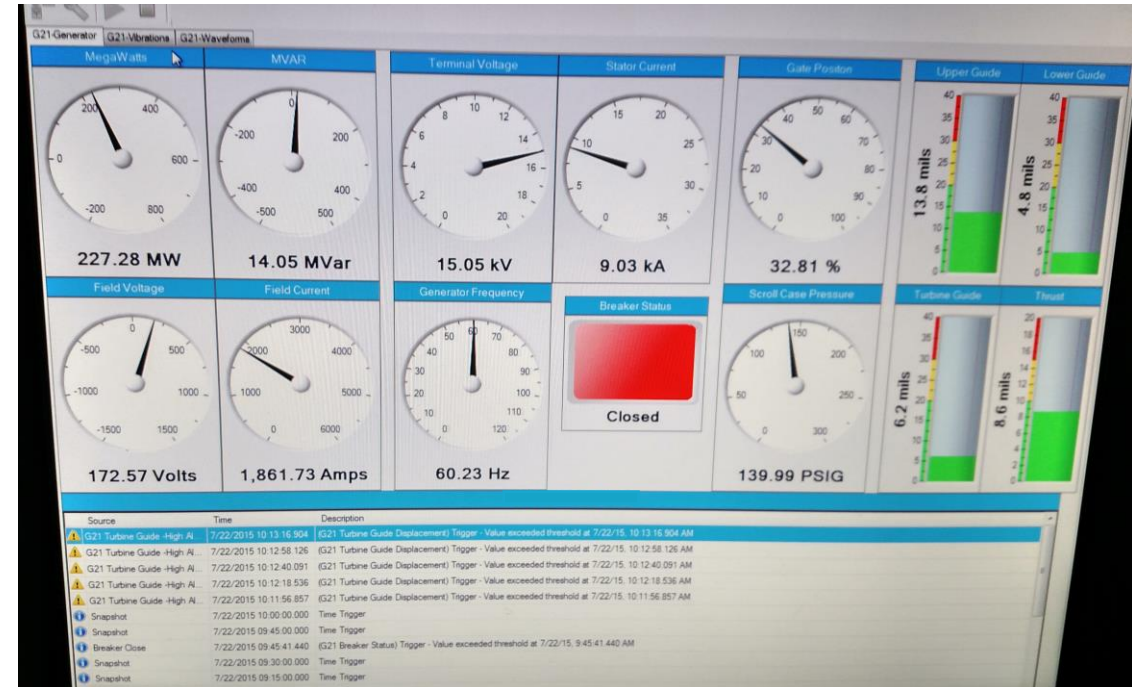
- Depending on needs at the facility, there may not always be employees with the exact skills to meet demands of the workload.
- The TSC can provide employees with specific skillsets to maximize efficiency at the facility.
 - This can include design, onsite testing, training of employees, and more.

Periodic Frequencies

- Our periodicity is defined as followed:
 - Plant Rounds: During plant checks, either per shift for manned facilities, weekly for un-manned facilities.
 - Daily: Working weekdays only
 - Weekly: Calendar week (Sunday to Saturday)
 - Monthly: Calendar month (first day through the last day of the month)
 - Quarterly: A calendar quarter consisting of 3 calendar months
 - Semi-annually: Six calendar months
 - Annually: A calendar year (January 1 through December 31)
 - Multi-year: Multiple calendar years (e.g., 5-year – January 1, 2021 through December 31, 2025)

Plant Rounds

- Weather recording instruments are checked.
- Plant PCLs status is verified.
- Tailrace and Forebay elevations are monitored.
- Protection system alarms and trips are reviewed.
- Station service battery float current and voltage is documented.



Plant Rounds

- Excitation system (slip rings, brushes for DC rotor)
- Governor
- Generator step-up transformer
- Switchyard
- Fire Protection (CO₂ System)



Plant Rounds



Plant Rounds

- Depression air system
- Service air and water
- Cooling water supply strainers
- Trashrack
- Spillways
- Gates



Typical Plant Rounds

- Auxiliary Machinery check on all floors using look, listen, feel, and smell during rounds.
- Readings and checks of all air systems for High- and Low-Pressure air used in plant service, control, and high-pressure air for the governors.
- Inspections of the sight glasses on all units for air depress.
- Inspections and readings on the cooling water pumps and supplied cooling water for shaft seals.
- Readings of the penstock and draft tube pressures.
- Inspection and readings on turbine and thrust bearings.



Typical Plant Rounds

- Visual inspection of
 - All switchgear and readings on the unit breakers.
 - All control panels and inspection of indicator lamps and relays.
 - Main distribution panel
 - All HVAC systems and equipment
 - Power transformer readings
 - All generator and pump monitoring equipment, including meter readings.





What do we do with the information we gain during plant rounds?

- At the beginning of each 12-hour shift a 15 min pass down on plant conditions and any alarms are discussed between off-going and on-coming operators.
- Any trouble reports are logged into CARMA as a Work Request with a follow up email sent to the Facility Manager and others for confirmation and repair action by creation of a workorder in CARMA.



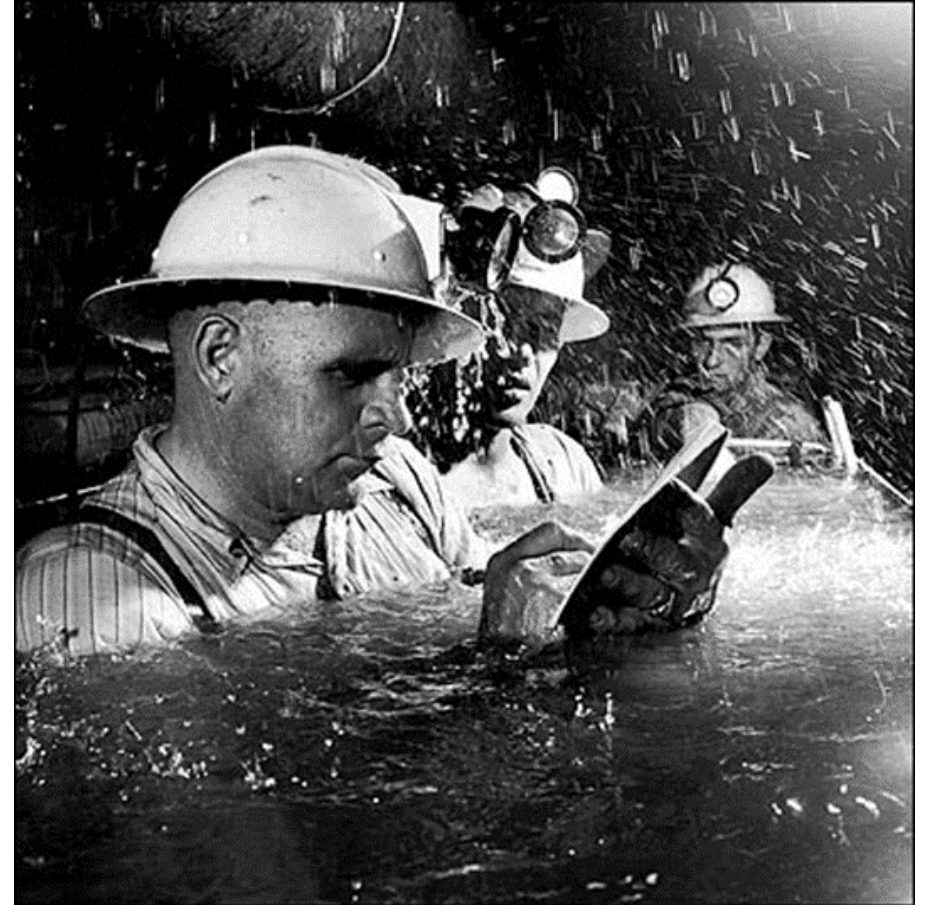
What do we do with the information we gain during a 12 hour shift a 15 min pass

- At the beginning of each 12 hour shift a 15 min pass is taken to check conditions and any alarms between off-going and on-coming shifts. If trouble reports are logged into CARMA as a Work Request with a follow up email sent to the Facility Manager and others for confirmation and repair action by creation of a workorder in CARMA.

If something does not seem quite right, bring it up and ensure it is checked.

Additional Duties Performed Daily

- Hourly recorded rounds in the control room of each machine condition for equipment that is online are recorded on a rounds sheet along with upper and lower reservoir levels and inflows from the water conduit.
- Starts/Stops and logs are kept all Units throughout the day.
- Clearances are written and approved as needed throughout the day for maintenance and testing.



What do we do with the data that is collected?

- Data from the daily checks must be properly documented, trended, and retained.
 - Documentation helps with future maintenance and testing, as well as regulatory requirements.
 - Data that is not trended over time only has value once equipment fails during the root cause analysis.
 - Trending data can allow us to catch problems before they become issues.




Other Periodic Checks

(Weekly, Monthly, Quarterly, etc....)



- Take information from scheduling documents and create workorders.
- Once created, workorders are automatically generated and then passed off to the appropriate individuals to complete.

Work Order: 123456

AO (ANY OFFICE AREA OFFICE) 

WO Description: APP - SEL 3118 NERC/WECC REGULATORY REQUIREMENT, PRC-008			
Location:	AA-BBB-PP-U1-PROT (UNIT 1, PROTECTION SYSTEM)	WO Priority:	4
Asset:	22557 (RELAYS, PROTECTIVE, UNIT 1)	Asset Priority:	4
FBMS Work Order:	R123456	Calc Priority:	8
WBS Element:	XXX2233XXZ2X	Reported Date:	05/04/2020
Fund:	22XR0680A4	Target Start:	05/04/2020
Reported By:	CASH, JOHN	Target Finish:	05/05/2020
On Behalf Of:		Scheduled Start:	
Supervisor:	JENNINGS, WAYLON	Scheduled Finish:	
Lead:	COE, DAVID ALLEN	Actual Start:	05/04/2020
Lead Craft:	EC-C&IMECH	Actual Finish:	
Reference:	-	Outage Required?:	N
Classification:	POWER \ NERC/WECC \ PRC-008 (null)	PM:	
Parent WO:		PM Compliance Range:	
		Clearance #:	

Child Work Orders
No Child Work Orders

Safety Plan Information
No Safety Plan

Job Plan
36241 MTE BASIC CORRECTIVE MAINTENANCE JOB PLAN

Task ID	Description	Completed?
10	CREATE A JOB HAZARD ANALYSIS FOR PROJECT JHA # _____	<input type="checkbox"/>
20	TEST ALL CRITICAL INPUTS There are not critical inputs	<input type="checkbox"/>
30	TEST ALL CRITICAL OUTPUTS Output 101 tested with RTS routine and tripped as expected. See testing process in log notes.	<input type="checkbox"/>
40	FORWARD TEST RESULTS TO MANAGER	<input type="checkbox"/>
50	COMMENTS	<input type="checkbox"/>

Task	Craft	Labor	Qty	Hours
	EC-C&IMECH		1.00	10.00

Materials
No Material Records

Tools
No Tool Records

Electrical Compliance Checks

- Determine if NERC requirements being met as generator owner/operators and transmission owner/operators
 - Are protection systems properly tested and coordinated?
 - Are we coordinating with neighboring utilities?
 - Do we have written evidence of the work that has been performed and is it easily accessible?

If we don't have documentation of the work that was performed, it never happened!



Environmental Compliance Checks

- Minimum flows
- Aeration
- Report spills of oils or hazardous materials
- Ramping rates
- Reservoir levels



National Pollutant Discharge Elimination System (NPDES) Permitting

- Powerhouse sump cleanup and containment
- Generator and other cooling water discharges
- Lubricant storage
- Stormwater
- Sandblasting, painting, cleaning, etc.
- Transformer containment – record keeping
- Oil sheen present in tailrace



Plant Alarms and Call-Outs (Annunciation Systems)

Manned facilities...

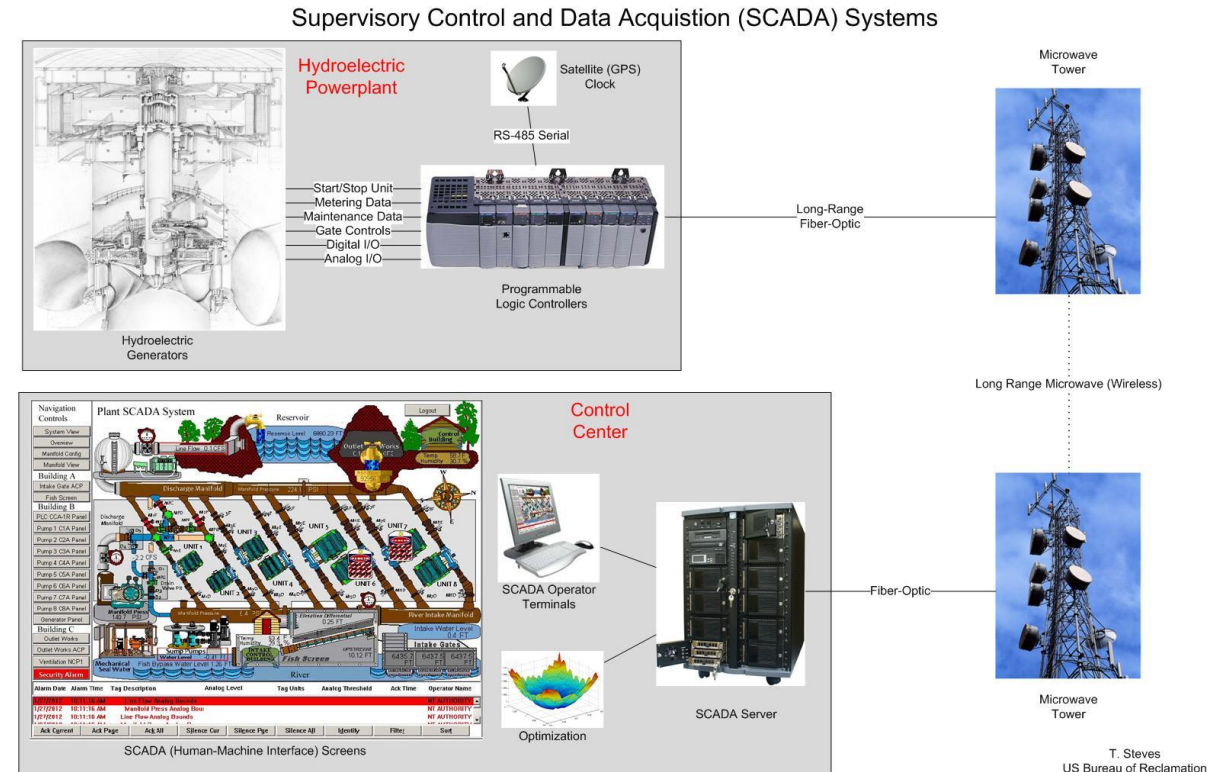
- Alarm sounds in control room and at Remote Control Center.
- The operator informs the facility manager of the issue.
- The facility manager prioritizes employees to resolve issues.



Plant Alarms and Call-Outs (Annunciation Systems)

For plants that are remotely operated or after hours...

- Alarm sounds in control room and at Remote Control Center.
- The operator or Remote Control Center calls the facility manager for the facility.
- The facility manager determines who is on call and dispatches employees, as needed.



Plant Alarms and Call-Outs (Annunciation Systems)

- In either instance, if additional support is needed, the facility manager or crafts can coordinate with other subject matter experts (i.e. TSC for Reclamation)
- TSC managers will determine the proper subject matter experts (SMEs) who can provide remote support.
- If remote support is not adequate, the SMEs can mobilize, typically in less than 24 hours and provide onsite assistance.



Unit/Spillway Operations

- If System Dispatch Center operates unit remotely
 - Communication and coordination between plant and the Center
- Flood Control
 - USACE flood control procedures
 - Discharge
 - Frequency of gate changes
 - Spillway gates (most operated on site)

Working with Labor Unions

- Collective Bargaining Agreement
- General working conditions
- Employee training
- Promotions-Demotions-Reductions
- Grievances
- Wages and classification
 - Plant auxiliary, Operator-Mechanic, Operator-Electrician, Hydro Journeyman, Controls and Instrumentation Technician, and more



Community/Public Relations

- Plant tours (students, civic groups, regulatory agencies, Homeland Security)
- Local Emergency Management Services support
- Presentations at schools
 - Try to reach students of all ages to get them interested in STEM.
- Branding of the organization



Plant Budget Administrator and Contract Coordination

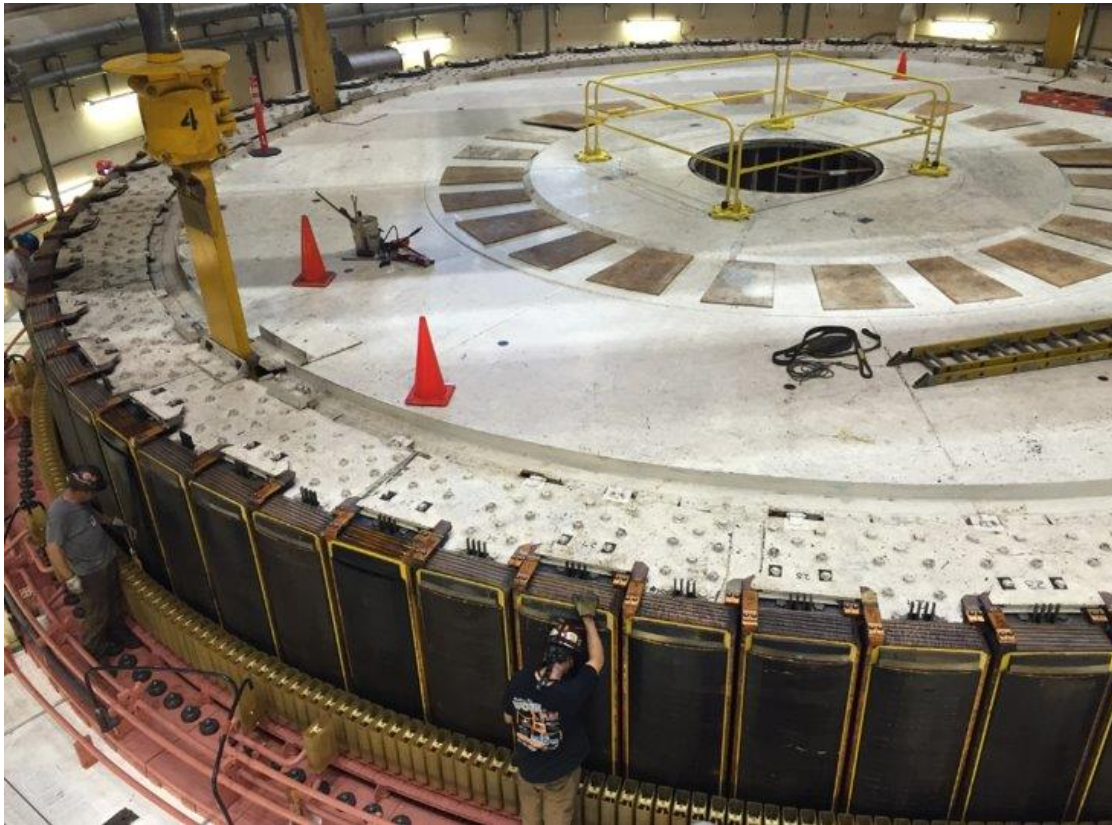
- Oversight of maintenance work orders from creation to approved status
- Role in bid process
 - Technical Proposal Evaluation Committee (TPEC)
 - Value Engineering (VE) Study
- Contractor orientation meetings
- Plan and coordinate contractors
- Contractor evaluations



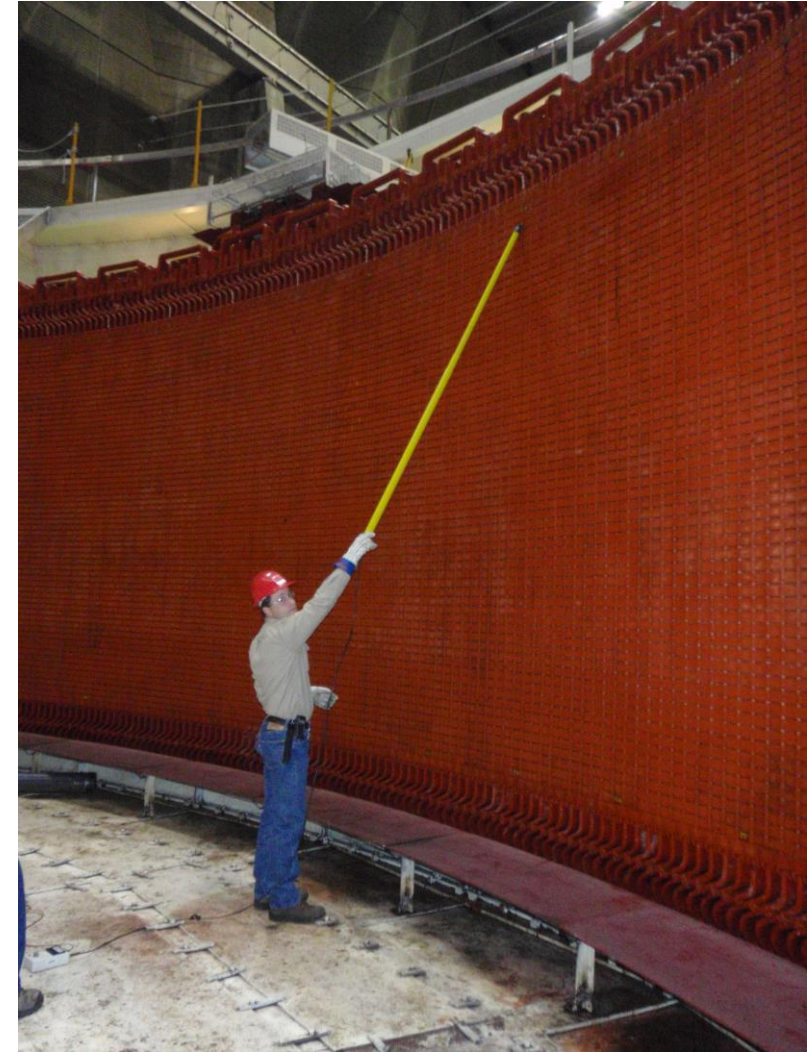
Tracking Major Plant Work



Tracking Major Plant Work



Tracking Major Plant Work



A Typical Day at the Plant

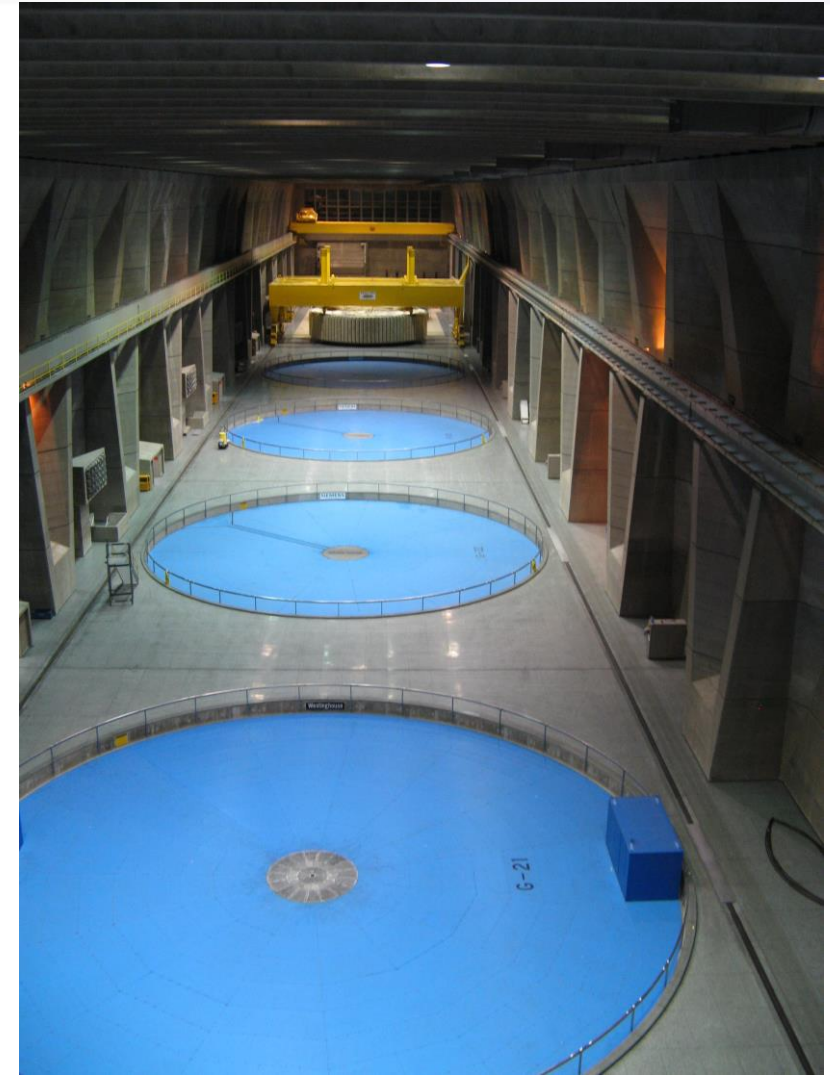
- Meet with the personnel (10-30 minutes)
 - What are we doing today?
 - What's coming up?
 - Who's working on it?
 - Do we have everything we need?
 - Job safety briefing
 - Acknowledge employees for a job well done.
 - Donuts or breakfast burritos never hurt!!
- Conference call between region and plant supervisors (15 minutes – 1 hour)
 - Manpower needs

A Typical Day at the Plant

- Perform a walkdown (1-hour minimum)
- Check electronic accounting/management system (30-minutes minimum)
 - Status of work orders, PMs, etc.
 - Condition reports
 - Address the issue
 - Open a work order
 - Go through budget
 - Status
 - Do now or wait until later
- Begin planning and coordination for future work tasks (30-minutes minimum)

A Typical Day at the Plant

- Work involvement with crew
 - Onsite at point of work
 - Support the crew
- Check-in with contractors
 - Orientation
 - Safety Training
 - Background checks
 - ID needed from everyone
 - Ensure there are no delays from lack of commination or local resources.
 - Work to resolve issues or concerns



At the end of the day, our Reclamation facility managers ensure the delivery of water and power to the American public while ensuring the safety of those who work in or around our power facilities.

Regardless to the size of the facility, their goal is the same.



Questions

